

## CLAIMS

Having thus described our invention, what we claim as new and desire to secure by Letters Patent is as follows:

1 A backlight apparatus comprising:

5 a wedge-type light guide having a refractive index  $n_1$ , and having a top surface, a bottom surface and a side surface;

a light source for directing light to said side surface of said wedge-type light guide;

a first light transmission layer having a refractive index  $n_2$ , which is smaller than said refractive index  $n_1$ , and having a top surface and a bottom surface, wherein said top surface of  
10 said first light transmission layer is attached to said bottom surface of said wedge-type light guide; and

a light deflecting layer having a top surface attached to said bottom surface of said first light transmission layer for deflecting the incident light from said first light transmission layer toward said top surface of said wedge-type light guide.

15 2. The backlight apparatus according to Claim 1, wherein the range of said refractive index  $n_1$  of said wedge-type light guide is approximately 1.4 through approximately 2.0, and the range of said refractive index  $n_2$  of said first light transmission layer is approximately 1.2 through approximately 1.4.

3. The backlight apparatus according to Claim 2, wherein said refractive index  $n_1$  of said wedge-type light guide is approximately 1.49, and said refractive index  $n_2$  of said first light transmission layer is approximately 1.3.

4. The backlight apparatus according to Claim 1, wherein the range of a top angle between said top surface and said bottom surface of said wedge-type light guide is approximately 0.1 through approximately 3 degrees.

5. The backlight apparatus according to Claim 2, wherein said light deflecting layer includes a second light transmission layer having a refractive index, which is substantially equal to said refractive index  $n_1$  of said wedge-type light guide, and a plurality of mirrors, each of which has a reflecting surface tilted by a selected angle from said top surface of said light deflecting layer to reflect said incident light from said first light transmission layer through said second light transmission layer toward a light path along a direction of a normal line of said top surface of said wedge-type light guide, and

wherein said second light transmission layer is attached to said bottom surface of said first light transmission layer, and said second light transmission layer and said plurality of mirrors are integrally formed.

6. The backlight apparatus according to Claim 2, wherein said light deflecting layer comprises a plurality of mirrors, each of which has a reflecting surface tilted by a selected angle from said top surface of said light deflecting layer to reflect said incident light from said first light

transmission layer toward a light path along a direction of a normal line of said top surface of said wedge-type light guide, and

wherein said first light transmission layer and said plurality of mirrors are integrally formed.

5 7. The backlight apparatus according to Claim 5, wherein said plurality of mirrors includes mirrors which have the reflecting surface tilted by said selected angle, mirrors which have the reflecting surface tilted by an angle larger than said selected angle, and mirrors which have the reflecting surface tilted by an angle smaller than said selected angle.

10 8. The backlight apparatus according to Claim 7, wherein said light source comprises a fluorescent lamp, and said light reflecting surface of each of said mirrors continuously extends in a direction, which is parallel to a center line of said fluorescent lamp.

9. A backlight apparatus comprising:

15 a wedge-type light guide having a refractive index  $n_1$ , and having a top surface, a bottom surface and a side surface;

a light source for directing light to said side surface of said wedge-type light guide;

a light transmission layer having a refractive index  $n_2$ , which is smaller than said refractive index  $n_1$ , and having a top surface and a bottom surface, wherein said bottom surface

20 of said light transmission layer is attached to said top surface of said wedge-type light guide;  
and

a plurality of prisms attached on said top surface of said light transmission layer for directing the incident light from said light transmission layer toward a light path along a direction of a normal line of said top surface of said light transmission layer.

10. The backlight apparatus according to Claim 9, wherein the range of said refractive index  $n_1$  of said wedge-type light guide is approximately 1.4 through approximately 2.0, and the range of said refractive index  $n_2$  of said light transmission layer is approximately 1.2 through approximately 1.4.

11. The backlight apparatus according to Claim 10, wherein said refractive index  $n_1$  of said wedge-type light guide is approximately 1.49, and said refractive index  $n_2$  of said light transmission layer is approximately 1.3.

12. A backlight apparatus comprising:

a wedge-type light guide having a refractive index  $n_1$ , and having a top surface, a bottom surface and a side surface;

a light source for directing light to said side surface of said wedge-type light guide;

15 a first light transmission layer having a refractive index  $n_2$ , which is smaller than said refractive index  $n_1$ , and having a top surface and a bottom surface, wherein said top surface of said first light transmission layer is attached to said bottom surface of said wedge-type light guide; and

a light deflecting layer having a top surface attached to said bottom surface of said first light transmission layer for separating colors of the incident light from said first light

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transmission layer and for directing the light of said separated colors toward said top surface of said wedge-type light guide.

13. The backlight apparatus according to Claim 12, wherein the range of said refractive index  $n_1$  of said wedge-type light guide is approximately 1.4 through approximately 2.0, and the  
5 range of said refractive index  $n_2$  of said first light transmission layer is approximately 1.2 through approximately 1.4.

14. The backlight apparatus according to Claim 13, wherein said refractive index  $n_1$  of said wedge-type light guide is approximately 1.49, and said refractive index  $n_2$  of said first light transmission layer is approximately 1.3.

10 15. The backlight apparatus according to Claim 13, wherein said light deflecting layer includes a second light transmission layer having a refractive index, which is substantially equal to said refractive index  $n_1$  of said wedge-type light guide, and a reflective diffraction grating for separating the incident light from said first light transmission layer through said second light transmission layer into light of red, green and blue colors, and for directing the light of the  
15 green color, the light of the blue color and the light of the red color, along three light paths, respectively,

wherein one of the three light paths is parallel to a normal line of said top surface of said wedge-type light guide, and the remaining two light paths are separated from said one light path, and

wherein said second light transmission layer and said reflective diffraction grating are integrally formed.

16. The backlight apparatus according to Claim 13, wherein said light deflecting layer comprises a reflective diffraction grating for separating the incident light from said first light transmission layer into light of red, green and blue colors, and for directing the light of the green color, the light of the blue color and the light of the red color, along three light paths, respectively,

wherein one of the three light paths is parallel to a normal line of said top surface of said wedge-type light guide, and the remaining two light paths are separated from said one light path, and

wherein said first light transmission layer and said reflective diffraction grating are integrally formed.

17. A liquid crystal display (LCD) apparatus comprising:

an LCD panel including an upper transparent substrate, a lower transparent substrate, and a liquid crystal material filled between said upper transparent substrate and said lower transparent substrate;

a light diffusing layer adjacent to said upper transparent substrate; and

a backlight apparatus adjacent to said lower transparent substrate, wherein said backlight apparatus comprises:

a wedge-type light guide having a refractive index  $n_1$ , and having a top surface, a bottom surface and a side surface;

a light source for directing light to said side surface of said wedge-type light guide;

a first light transmission layer having a refractive index  $n_2$ , which is smaller than said refractive index  $n_1$ , and having a top surface and a bottom surface, wherein said top surface of said first light transmission layer is attached to said bottom surface of said wedge-type light guide; and

a light deflecting layer having a top surface attached to said bottom surface of said first light transmission layer for deflecting the incident light from said first light transmission layer toward said LCD panel through said top surface of said wedge-type light guide.

18. The LCD apparatus according to Claim 17, wherein the range of said refractive index  $n_1$  of said wedge-type light guide is approximately 1.4 through approximately 2.0, and the range of said refractive index  $n_2$  of said first light transmission layer is approximately 1.2 through approximately 1.4.

15 19. The LCD apparatus according to Claim 18, wherein said refractive index  $n_1$  of said wedge-type light guide is approximately 1.49, and said refractive index  $n_2$  of said first light transmission layer is approximately 1.3.

20 20. The LCD apparatus according to Claim 18, wherein a color filter is formed on an inner surface of said upper transparent substrate.

21. The LCD apparatus according to Claim 18, wherein said light deflecting layer includes a second light transmission layer having a refractive index, which is substantially equal to said refractive index  $n_1$  of said wedge-type light guide, and a plurality of mirrors, each of which has a reflecting surface tilted by a selected angle from said top surface of said light deflecting layer  
5 to reflect said incident light from said first light transmission layer through said second light transmission layer toward a light path along a direction of a normal line of said top surface of said wedge-type light guide, and

wherein said second light transmission layer is attached to said bottom surface of said first light transmission layer, and said second light transmission layer and said plurality of  
10 mirrors are integrally formed.

22. The LCD apparatus according to Claim 18, wherein said light deflecting layer comprises a plurality of mirrors, each of which has a reflecting surface tilted by a selected angle from said top surface of said light deflecting layer to reflect said incident light from said first light transmission layer toward a light path along a direction of a normal line of said top surface of  
15 said wedge-type light guide, and

wherein said first light transmission layer and said plurality of mirrors are integrally formed.

23. A liquid crystal display (LCD) apparatus comprising:

an LCD panel including an upper transparent substrate, a lower transparent substrate,  
20 and a liquid crystal material filled between said upper transparent substrate and said lower transparent substrate;



a light diffusing layer adjacent to said upper transparent substrate; and  
a backlight apparatus adjacent to said lower transparent substrate, wherein said  
backlight apparatus comprises:

a wedge-type light guide having a refractive index  $n_1$ , and having a top  
5 surface, a bottom surface and a side surface;  
a light source for directing light to said side surface of said wedge-type light  
guide;

a light transmission layer having a refractive index  $n_2$ , which is smaller than  
said refractive index  $n_1$ , and having a top surface and a bottom surface, wherein said bottom  
10 surface of said light transmission layer is attached to said top surface of said wedge-type light  
guide; and

a plurality of prisms attached on said top surface of said light transmission  
layer for directing the incident light from said light transmission layer toward a light path along  
a direction of a normal line of said top surface of said light transmission layer.

15 24. The LCD apparatus according to Claim 23, wherein the range of said refractive index  $n_1$  of  
said wedge-type light guide is approximately 1.4 through approximately 2.0, and the range of  
said refractive index  $n_2$  of said light transmission layer is approximately 1.2 through  
approximately 1.4.

25. The LCD apparatus according to Claim 24, wherein said refractive index  $n_1$  of said  
20 wedge-type light guide is approximately 1.49, and said refractive index  $n_2$  of said light  
transmission layer is approximately 1.3.

26. A liquid crystal display (LCD) apparatus comprising:

an LCD panel including an upper transparent substrate, a lower transparent substrate, and a liquid crystal material filled between said upper transparent substrate and said lower transparent substrate;

5 a light diffusing layer adjacent to said upper transparent substrate; and

a backlight apparatus adjacent to said lower transparent substrate, wherein said backlight apparatus comprises:

a wedge-type light guide having a refractive index  $n_1$ , and having a top surface, a bottom surface and a side surface;

10 a light source for directing light to said side surface of said wedge-type light guide;

a first light transmission layer having a refractive index  $n_2$ , which is smaller than said refractive index  $n_1$ , and having a top surface and a bottom surface, wherein said top surface of said first light transmission layer is attached to said bottom surface of said

15 wedge-type light guide; and

a light deflecting layer having a top surface attached to said bottom surface of said first light transmission layer for separating colors of the incident light from said first light transmission layer and for directing the light of said separated colors toward said LCD panel through said top surface of said wedge-type light guide.

20 27. The LCD apparatus according to Claim 26, wherein the range of said refractive index  $n_1$  of said wedge-type light guide is approximately 1.4 through approximately 2.0, and the range of

said refractive index  $n_2$  of said first light transmission layer is approximately 1.2 through approximately 1.4.

28. The LCD apparatus according to Claim 27, wherein said refractive index  $n_1$  of said wedge-type light guide is approximately 1.49, and said refractive index  $n_2$  of said first light  
5 transmission layer is approximately 1.3.

29. The LCD apparatus according to Claim 27, wherein said light deflecting layer includes a second light transmission layer having a refractive index, which is substantially equal to said refractive index  $n_1$  of said wedge-type light guide, and a reflective diffraction grating for separating the incident light from said first light transmission layer through said second light  
10 transmission layer into light of red, green and blue colors, and for directing the light of the green color, the light of the blue color and the light of the red color, along three light paths, respectively,

wherein one of the three light paths is parallel to a normal line of said top surface of said wedge-type light guide, and the remaining two light paths are separated from said one light  
15 path, and

wherein said second light transmission layer and said reflective diffraction grating are integrally formed.

30. The backlight apparatus according to Claim 27, wherein said light deflecting layer comprises a reflective diffraction grating for separating the incident light from said first light  
20 transmission layer into light of red, green and blue colors, and for directing the light of the

green color, the light of the blue color and the light of the red color, along three light paths, respectively,

wherein one of the three light paths is parallel to a normal line of said top surface of said wedge-type light guide, and the remaining two light paths are separated from said one light path, and

wherein said first light transmission layer and said reflective diffraction grating are integrally formed.

31. The LCD apparatus according to Claim 29, further comprising a lens array arranged between said lower transparent substrate and said top surface of said wedge-type light guide, said lens array directing said light of the blue color, said light of the green color and said light of the red color to three adjacent sub-pixels of said LCD panel, respectively.

32. A light guide apparatus comprising:

a wedge-type light guide having a refractive index  $n_1$ , and having a top surface, a bottom surface and a side surface;

a light transmission layer having a refractive index  $n_2$ , which is smaller than said refractive index  $n_1$ , and having a top surface and a bottom surface, wherein said top surface of said light transmission layer is attached to said bottom surface of said wedge-type light guide; and

a light deflecting layer having a top surface attached to said bottom surface of said light transmission layer for deflecting the incident light from said light transmission layer toward said top surface of said wedge-type light guide.

33. A light guide apparatus comprising:

a wedge-type light guide having a refractive index  $n_1$ , and having a top surface, a bottom surface and a side surface;

5 a light transmission layer having a refractive index  $n_2$ , which is smaller than said refractive index  $n_1$ , and having a top surface and a bottom surface, wherein said bottom surface of said light transmission layer is attached to said top surface of said wedge-type light guide; and

a plurality of prisms attached on said top surface of said light transmission layer for  
10 directing the incident light from said light transmission layer toward a light path along a direction of a normal line of said top surface of said light transmission layer.

34. A light guide apparatus comprising:

a wedge-type light guide having a refractive index  $n_1$ , and having a top surface, a bottom surface and a side surface;

15 a light transmission layer having a refractive index  $n_2$ , which is smaller than said refractive index  $n_1$ , and having a top surface and a bottom surface, wherein said top surface of said light transmission layer is attached to said bottom surface of said wedge-type light guide; and

a light deflecting layer having a top surface attached to said bottom surface of said  
20 light transmission layer for separating colors of the incident light from said light transmission layer and for directing the light of said separated colors toward said top surface of said wedge-type light guide.